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Age at Immigration and the Education Outcomes of Children

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..   not available for a specific reference period
...   not applicable
0   true zero or a value rounded to zero
0^s value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
p   preliminary
r   revised
x   suppressed to meet the confidentiality requirements of the *Statistics Act*
E   use with caution
F   too unreliable to be published
*   significantly different from reference category ($p < 0.05$)

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Abstract

The education outcomes of a cohort of immigrants who arrived in Canada as children were examined using the 2006 Census, and it was found that there may be a distinct pattern in the risk of immigrant children graduating from high school according to age at arrival. The risks of not completing high school do not vary according to age at arrival up to about the age of 9, with children arriving after that age appearing to face a distinct and growing increase in the risk that they will not graduate. Children who migrate may face different challenges in attaining high school credentials, according to their age at immigration, as a result of sensitive periods in the acquisition of a second language or the structure of the education system.

Executive Summary

The analysis in this paper focuses on the following question: how would the education outcomes of a child differ if he or she had migrated at a different point in the life cycle? This question has public policy importance because it sits at the crossroads of two important concerns: What are the factors explaining the successful adaptation of immigrants to the Canadian labour market? and how does migration affect the well-being of children?

Focusing on this question is one way of allowing the concerns of immigrant children to be informed by the research on child development. This growing literature underscores the importance of the early years in determining adult social and economic success. The suggestion that the full development of a child's social and cognitive competencies passes through a series of stages in which competencies at one stage build the foundation for subsequent developments implies the need to give distinct attention to immigrant children. Children, in a way different from adults, face important transitions in their lives, and migration may have long-lasting impacts on their capacities to become successful and self-reliant adults, impacts that may be much more costly and difficult to remedy at a later stage.

More specifically, the research summarized in this paper documents the degree to which high school graduation for immigrant children may change discretely after a particular age at arrival in Canada. This analysis looks at the education outcomes of a large sample of adults who came to Canada as children drawn from the 2006 Census of Population, which offers a very large and representative sample to document high school graduation by age at arrival, but also according to the country of origin and from English or French.

There are three main conclusions. First, there appears to be a distinct pattern in the risks of not obtaining a high school diploma that varies with age at arrival consistent with a sensitive period in learning a second language. The risks of not graduating from high school are estimated to be about 15% for boys and 11% for girls who came to the country before 9 years of age. They increase by over 1 percentage point for every year past this age, reaching 20% to 25% for those arriving in the country after the age of 13. These results are robust to controls for the possibility that first exposure to English or French occurred before migration.

Second, these patterns may have something to do with the challenges children face in learning a second language, since these challenges vary in a predictable way according to the linguistic distance of the language of the country of origin from English or French. There is no discernable pattern between high school graduation and age at arrival for those who came to Canada from English-speaking or French-speaking countries. Though the overall levels in high school graduation may vary significantly across other countries of origin, the nature of the pattern is the same: no change in the early years, followed by a distinct change. This threshold varies somewhat between countries of origin but generally corresponds to the first years of primary school, being as young as 5 for some regions and likely no older than 9 in others.

Third, the underlying reasons for these findings require further study. The research has the benefit of using a large and diverse sample of immigrants as well as controls for some of the more important aspects of the underlying heterogeneity. The focus was on education outcomes, given the policy relevance of the issue, but the patterns uncovered are distinct and robust in a way that cannot be described of previous research that has focused specifically on language proficiency. More detailed analysis is necessary in order to discern the degree to which the findings are due to maturational changes in the cognitive capacities of children to learn a second language, sensitive periods in their social development, or institutional features of the education system whereby the latter is not sufficiently attuned to the needs of, and challenges facing, children in senior primary school or young adolescents.

1   Introduction

There is no simple or single answer to the question of how migration influences the well-being of children. The answer will very much depend upon the counterfactual state that represents the basis for any causal comparison. Would the child have been better off: if the parents had decided not to emigrate; if the parents had immigrated to a different country; if the parents had immigrated at a different point in the child's life cycle; or if the parents had given birth in the new country? Each question presupposes a different counterfactual, all of these being relevant to an assessment of the child's well-being.

Even this series of questions does not exhaust the possible dimensions of the issue. But keeping the counterfactual explicitly in mind does help in terms of structuring the analysis; keeping its relevance in perspective; and, ultimately, highlighting the possible public policy mechanisms that can be both addressed and evaluated. The analysis in this paper focuses on only one of these questions and on a particular measure of child well-being: how would the education outcomes of a child differ if he or she had migrated at a different point in the life cycle? Focusing on this question is one way of allowing the concerns of immigrant children to be informed by the research on child development. This growing literature underscores the importance of the early years in determining adult social and economic success. The suggestion that the full development of a child's social and cognitive competencies passes through a series of stages in which competencies at one stage build the foundation for subsequent developments implies the need to give distinct attention to child migrants. Children, differently from adults, face important transitions in their lives, and migration may have long-lasting impacts on their capacities to become successful and self-reliant adults, impacts that may be much more costly and difficult to remedy at a later stage.

The next section briefly sketches this literature, particularly with reference to sensitive periods in second-language acquisition. The objective of the analysis in the subsequent sections is to uncover the extent and nature of distinct periods during which there is a greater risk of not completing high school. Does the likelihood of high school graduation for immigrant children change discretely when they arrive in the host country after a certain age?

This is an exercise in description, and there is a certain caution required in ascribing a causal interpretation to the findings. As such, this research is the first step in answering the question of whether a particular child would have been better off if his or her parents had changed countries when he or she was younger or older. Causal inference is difficult to make because the same child is not observed in two different situations, and a randomized experiment cannot be relied upon. The analysis is based upon observational data potentially subject to selection problems that make a clear causal inference difficult without convincingly controlling for the unobserved influences that may vary with the child's age at arrival in the destination country. This said, the analysis of Canadian census data, which is described in Section 3, offers a very large and representative sample to document high school graduation by age at arrival, but also according to the country of origin and its linguistic distance from English or French, Canada's two official languages.

The findings are presented in Sections 4 and 5. They suggest that there is in fact a distinct age beyond which immigrant children experience a greater risk of not completing high school, that this age may be associated in a predictable way with the extent of the challenges faced in learning one of Canada's official languages, and that it is likely no older than 9. This point in the child's life cycle is associated with the period when elementary-school-aged children are making the transition from what has been referred to by Douglas Willms as "learning to read" to "reading to learn." It is not possible to distinguish the separate role of the social and learning environments of schools in determining this outcome, from the role of maturational changes children go through during this period in their lives. Consequently, the threshold uncovered

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could well reflect the structure of the education system and public policy choices as much as it reflects sensitive periods in the child's development.

2   Overview and motivation

The importance of the early years with respect to the development of the adult capacities of children is studied and acknowledged in a large growing literature from a number of different disciplines. Knudsen *et al.* (2006) offer a particularly clear and succinct summary of the major findings, but, just as importantly, they sketch out the logic of an argument stressing the relevance for public policy. Their discussion begins with the observation that early experiences seem to have long-lasting consequences, influencing adult competencies as well as social and labour market success. How and why this occurs has important implications, in their view, for the future productivity of society, and raises a need for public policy to invest in the development of young children from disadvantaged backgrounds.

Their policy recommendations rest on the claim that the returns to social investments in children during the early years exceed those offered to school-age children, which in turn are greater than remedial training offered to adults: "the most cost-effective strategy for strengthening the future American workforce," the authors state, "is to invest greater human and financial resources in the social and cognitive environments of children who are disadvantaged, beginning as early as possible. The greatest return derives from investing in disadvantaged children because their home environments are impoverished." (Knudsen *et al.* 2006, p. 10161)

Early experiences influence social, emotional, and cognitive capacities in a way that impacts upon adulthood because learning is hierarchical and because it progresses through a series of so-called "sensitive" periods. The early development of skills influences the ability to master related skills and other skills, and ultimately determines competencies at later stages in life. "Skills beget skills": capabilities at a particular point in life are based upon foundations set at earlier points. Learning is subject to sensitive periods during which specific skills can be mastered with greatest ease and productivity. Knudsen *et al.* (2006) make a point of citing language acquisition as illustrating this hierarchical process, subject to sensitive periods, highlighting second-language acquisition. "Learning a second language as an adult requires far greater effort than learning it as a child, and the result is never as complete" (Knudsen *et al.* 2006, p. 10158). Knudsen et al. make note of Johnson and Newport (1989), a study of 46 Chinese and Korean immigrants who came to the United States as children and whose English proficiency was tested in adulthood after at least 10 years after arrival. In this study, Knudsen et al. claim that proficiency does not vary with age at arrival up to the age of 7 and deteriorates further with each subsequent year. By late adolescence, language proficiency is no better than for those who arrived as adults in their 20s and 30s.

This in part explains the interest of social scientists in the acquisition of a second language by immigrants, who in some sense experience a sharp depreciation in the value of competencies obtained by means of the language of their country of origin. The fact that their competencies may not be suited to the language in their country of destination and the fact that language acquisition must start anew at an older stage in life offer a test of the relevance and importance of sensitive periods in the learning process. This is an aspect of why the study of immigrant children deserves attention. Children are likely to experience migration differently than adults, with distinct opportunities and challenges as a result of how the learning process occurs. Further, if the logic of the public policy argument put forward by Knudsen *et al.* (2006) is to be accepted, children also represent a group for which public policy, for better or worse, can make a difference in long-term outcomes that have broad social implications.

Thomas and Johnson (2008), Birdsong (2006), and many of the essays in Birdsong (1999) offer an overview of the literature on language acquisition in general as well as on second-language acquisition. The theoretical research in this area often associates sensitive periods with puberty, though there does not appear to be a consensus on this. Some theoreticians consider 5 or 6 years of age to be an important turning point; others side with 12 to 15 years. Further, in some

perspectives, puberty is associated with the stage at which declines in second-language competencies end, but in others with the stage at which the declines begin (Birdsong 2006).

The empirical literature is addressed to the exact timing of any discrete changes in the relationship between age at arrival and second-language competence. In fact, the study by Johnson and Newport (1989), who focus on a test of grammatical judgment, is only one of many empirical studies adopting this research design. Flege (1999) and Flege, Munro, and MacKay (1995) are of particular interest as they describe results from a sample of 240 Italians who came to Canada as children or young adults, and had been in the country for an average of 32 years when studied. The focus of those two studies, like that of much of this literature, is on the degree to which the second language is spoken with a foreign accent. In this research, the capacity to speak English with a native-like accent declines linearly with age, and no distinct thresholds are apparent in the data.

Chiswick and Miller (2008) and Hakuta, Bialystok, and Wiley (2003) are also of interest in that the U.S. Census is used to study the self-reported language abilities of a large sample of immigrants. Hakuta et al. (2003) study 2.3-million immigrants of Spanish and Chinese backgrounds who had been in the country at least 10 years. They find a linear decline in language ability and no evidence of discontinuities. Their analysis, however, does not focus on children and is restricted to examining possible discontinuities at ages 15 and 20 years. Chiswick and Miller (2008) offer a more comprehensive use of the data, but reach broadly similar conclusions. In fact, the reviews by Birdsong (2006, 1999) suggest that the evidence is not clear; this in part reflects methodological differences associated with different outcomes and disaggregation of the data across studies. These studies are often based on relatively small samples of specific groups, often with little control for possible other influences, Hakuta et al. (2003) and Chiswick and Miller (2008) being notable exceptions.

This is a somewhat more ambiguous picture than that painted by Knudsen et al. (2006) and by other analysts and advocates of the importance of the early years for public policy, but it should be noted that the focus is on a limited set of outcomes which may be associated in varying degrees with social and economic success in adulthood depending upon the context.

Accordingly, the outcome focused upon in this paper is not language skills, but one that is more directly tied to socio-economic outcomes in adulthood—high school graduation—though perhaps less informative about the specific mechanisms at work. Educational attainment is directly related to future productivity, but, in addition to being associated with maturational changes associated with language competencies, it also highlights the role of public policy. The structure of the school environment, as both a learning and a social environment, is also likely to be associated with outcomes. Even when there are no sensitive periods in language acquisition, these may be evident in eventual education attainment because the structure of the schooling system may accentuate, rather than alleviate, the challenges that migration implies for children. In other words, it may well be that "skill begets skill", but this could reflect institutions that do not offer children more than one opportunity to master skills necessary for further advancement. Since some aspects of learning are progressive, math skills perhaps being the most obvious example, even a temporary event that prevents children from fully mastering the skill at a given age when it is first presented in the curriculum may have long-lasting consequences if the education system does not offer other opportunities to develop the missed foundational skills at a later stage. In particular, early and strongly enforced tracking could have consequences for long-term outcomes even if there were no sensitive periods in the development of cognitive and social competencies.

3   Data and measurement

The analysis made use of the 2006 Canadian Census. The census was administered to all households, but a random sample of 20% of the population was required to complete the "long form" version of the questionnaire, offering detailed socio-economic information on a very large number of respondents. This was the source of the analysis because it offers information on educational attainment, but also information on immigration background including country of origin and age at arrival. The potentially very large sample size makes these data one of the more important sources of information on immigrants to Canada, supporting a large number of studies on immigration but surprising few specifically on immigrant children.[1]

The file for analysis was based upon all adults aged 35 to 55 in 2006, a sample of about 2.1 million representing a population of 10.2 million. A number of restrictions are used to ensure accuracy and consistency of the data, but principally to restrict the respondents to those who report they are immigrants arriving in the country before the age of 18. These restrictions lead to a sample size of 111,302.[2]

The analysis focused on age at arrival, calculated from information on the year the individual recalls arriving in Canada.[3] It should be distinguished from a number of concepts used in the second-language-acquisition literature, which are likely to be more conceptually relevant measures. The most studied measure, and the one considered the most strongly predictive of second-language competencies, is age of acquisition. This refers to the age at which the individual is first immersed in the new language context. Age of acquisition may not be the same thing as age at arrival if, for example, a child arrived in the country during the pre-school years and was not exposed to English or French until the time he or she started school. Both of these measures are also distinct from age of first exposure, which denotes when the individual first became exposed to the second language. This could well be before age at arrival, as a result of the language of instruction in formal schooling in the country of origin, visits to other countries, or contact with relatives or other speakers of the second language. Age at arrival will often coincide with age of acquisition, but obviously this is not an experience that will characterize all immigrants from the many different source countries to Canada or even all immigrants from the

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1. Aydemir, Chen, and Corak (2009a,b) use the 2001 version of these data to study second-generation Canadians, while Ferrer and Riddell (2008) and Schaasfma and Sweetman (2001) use similar public-use versions on earlier years to offer evidence of earnings and age at arrival. Ferrer, Green, and Riddell (2006) also examine issues associated with age at arrival from other surveys. See also Ornstein (2007, 2006a) for the use of the full version of the long-file respondents, though he does not focus on age at arrival. Böhlmark (2009, 2008) and Gonzalez (2003) are examples of studies from other countries using large samples of representative data to study education and earnings outcomes. Both authors find that education outcomes deteriorate for those children migrating after the age of 9. Böhlmark (2009, 2008) examines immigrant children in Sweden with administrative data and finds that this is the case for grade point average (GPA) and final grades but not necessarily for level of education attainment, while Gonzalez using U.S. Census data finds that the negative impact of arrival after about the age of 9-to-12 is strongest for those coming from Mexico. Böhlmark (2009) is a notable reference since particular attention is paid to selection biases that may make causal inference difficult. Böhlmark uses sibling differences to identify a causal impact and finds that the results are in fact similar to cross-sectional regressions controlling for country of origin and parental education.
2. The details of this sample selection process are described in Appendix Table A.1.
3. Strictly speaking, this is the age at which the individual acquires landed immigrant status, but it is unclear whether respondents answer the question in this way. Further, it should be noted that individuals who recently entered the country as refugees are not included in the analysis. These individuals do not have a value for the year at arrival because they do not have landed immigrant status. This also implies that it is not possible to know whether a given immigrant initially came as a refugee, and then subsequently received landed immigrant status and even citizenship. For all immigrants who came as refugees, the age-at-arrival variable in the authors' analysis will, in a sense, overstate the true age at arrival if the respondents do in fact report on the year in which landed immigrant status was obtained. This would not capture any time spent in the country prior to becoming a landed immigrant.

same source country.[4] Further, there will be a potential bias in using the data to uncover a sensitive period to the extent that age at arrival differs from age of first exposure.

The total sample size consisted of 55,016 men and 56,286 women. There are on average 3,056 observations for men and 3,127 observations for women at each age at arrival. The analysis was restricted to individuals who arrived before the age of 18, in part to focus on individuals considered to be children under the terms of the UN Convention on the Rights of the Child, but also because there was a sharp rise in the number of individuals who arrived in the country between the ages of 18 and 20.[5] Though individuals under the age of 21 may be admitted into the country with their parents and considered as children, this increase suggests that this population likely also comprises a significant number of individuals who arrived as independent immigrants.[6]

While roughly 3,000 individuals arrived in the country at each age between newborn and 17 years, it was also the case that (with the possible exception of the oldest category) the largest fraction of children arrived in the country between the ages of 1 and 5. This raises the possibility that some parents time their migration decision with the welfare of their children in mind. If parents consider the possible effects of age at arrival on their children's welfare when timing their decision to emigrate, it is possible that the distribution of unobserved parental characteristics may vary across the age-at-arrival distribution. More motivated or altruistic parents who are more inclined to invest effectively in their children may be over-represented in groups that have an early age at arrival. Their children will perform better than a randomly selected group of children as a result of the enriched environment in which they were raised; this makes comparisons and causal inferences across age-at-arrival thresholds suspect. At the same time, it should also be noted that generally parents do not have complete discretion as to when they will emigrate, applications being subject to administrative rules and delays; consequently, the scope for selection biases of this sort may be constrained.

The information that respondents provided about their country of origin was used to classify each country of origin into broad categories according to the linguistic distance of the dominant language spoken in the country from English, as well as to add a classification for English-speaking and French-speaking countries. In order to do this, the measure of linguistic distance developed by Chiswick and Miller (2005) was used; minor corrections were made and the measure adapted to the Canadian case. There is no equivalent indicator available for linguistic distance from French; however, the analysis does distinguish countries of origin in which French is predominantly spoken. For these countries, as is the case for English-speaking countries of origin, the linguistic distance does not apply.

The categorization, based on the dominant language in the country of origin, involved first creating a correspondence between the language codes in Chiswick and Miller (2005) for the U.S. Census and those in the Canadian census. Not all of the languages they used were found in the Canadian census; a correspondence was established by aggregating languages where necessary. This permitted a characterization of all the languages into three categories: "Low," "Medium," and "High." The "Low" category collected languages that were farthest from English, having a score lower than 2.00 under the Chiswick and Miller measure; the languages under the "Medium" category are a medium distance to English, having a language score equal to 2.00;

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4. For a more detailed discussion, see Birdsong (2006, p. 11–12), who also offers length of residence as another distinct measure.
5. This is particularly the case at ages 18 and 19, when 4,005 and 4,392 men, and 4,686 and 5,872 women, respectively, report arriving in the country. These numbers fall at age 20 to the range of earlier ages, about 3,000. For further details, see the working paper version at http://www.iza.org/profile?key=83.
6. This said, it should also be noted that younger children may arrive in the country independently. These individuals may be as young as 16 or 17 and may come for short periods to study in Canadian high schools as part of student exchanges. To the extent that they remain in Canada or emigrate as adults from their country of origin at a later date, they may also play a part in influencing the patterns in these data.

and the "High" category referred to languages closest to English, with respect to languages having linguistic scores of more than 2.00. [7]

The next step in categorizing the over-100 countries of origin that appear in the data for this study required using the full sample of immigrants from the census data (not just the immigrant children and young adults, who are 35 to 55 years old in 2006). If over 75% of the people coming from a particular country spoke a language that fell into one of the five categories—Low, Medium, High, English, French—then the country of origin was assigned that category. Some individuals in the sample cannot be categorized with confidence because more than one language was spoken in their country of origin. This ambiguity affected about 10% of the sample, with the result that over 90% of the individuals in the analytical sample were assigned a language category. This led to a smaller sample of 101,884, made up of 50,253 men and 51,631 women, which was used when linguistic distance formed part of the analysis.

The sample was further sub-divided into particular source countries to the extent permitted by sample size. On this basis, the English-speaking source regions were: the United Kingdom; the United States; and the Rest of the World in which English is spoken. Source countries whose language had a "High" linguistic similarity to English were also divided into three groups: Italy; Portugal; and the Rest of the World with a high language score. The groups with a "Low" linguistic similarity were: Hong Kong; India; and the Rest of the World with a low language score. Two remaining groups were: those originating from countries of origin whose language was French; and those whose language was at an intermediate distance from English, referred to as "Medium."[8]

A summary of the sample sizes and proportions by region of origin classified into these eleven groups is offered in Table 1. Immigrants from the United Kingdom represented just over one-fifth of the entire sample, and as a group those from English-speaking countries represented about 40%. Immigrants from countries with a high similarity to English were the next-largest group, collectively representing about one-third of the sample. The smallest group were those from French-speaking regions, with just under 3.0% of the total sample.

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7. In the process of creating this language-to-language score mapping, some discrepancies were discovered in the table presented by Chiswick and Miller. For example, Burmese appeared in two separate sections with a different language score assigned to it in each instance. Fortunately, Burmese was not a language that appeared in the Canadian census code set; consequently, this turned out not to be problematic. However, in the case of Thai and Laotian, the discrepancy was important. In one instance, Laotian was listed as the primary language having a language score of 1.50, with Thai listed as being in the same group. In the second instance, the reverse is listed (Thai being primary, and Laotian being in the same group) but with a language score of 2.00. With the language scores being so different, the language group assigned to these languages would change according to which score were used. To address this problem, the two languages were considered to be independent from the primary language having the "correct" score assigned to it. Consequently, Laotian was given a score of 1.50, which put it in the "Low" category, while Thai was assigned a score of 2.00, which placed it in the "Medium" category. There were also a small number of languages that could not be categorized, and these were excluded from the analysis.

8. A detailed listing of the countries that fall into these groups is provided in the Appendix as Table A.2.

Table 1
Sample sizes and proportions by regions of origin classified according to linguistic distance from English and French, men and women

	Men		Women	
	Unweighted sample size	Proportion	Unweighted sample size	Proportion
	number	percent	number	percent
English				
Rest of world	5,131	10.2	5,946	11.5
United Kingdom	10,693	21.3	10,916	21.1
United States	3,899	7.8	4,510	8.7
French	1,285	2.6	1,477	2.9
High similarity to English				
Italy	5,687	11.3	5,518	10.7
Portugal	3,803	7.6	3,866	7.5
Rest of world	7,039	14.0	6,957	13.5
Low similarity to English				
Hong Kong	1,786	3.6	1,774	3.4
India	2,004	4.0	1,973	3.8
Rest of world	4,841	9.6	4,510	8.7
Medium similarity to English	4,085	8.1	4,184	8.1
Total	50,253	100.0	51,631	100.0

Note: Percentages may not add up to 100% because of rounding.
Source: Author's calculations using Statistics Canada, 2006 Census according to the selection rules described in the text.

4   Overall descriptive results and some cautions

The weighted averages of individuals not having a high school diploma for each age at arrival were calculated from these data, and are offered in Figure 1 along with a local polynomial smooth of the data.[9] This is the major descriptive finding, motivating more in-depth analysis. There is a clear and distinct variation in the chances of high school graduation. At the broadest level, this is in accord with the hypothesis of a sensitive period: there are no changes in the proportion of high school drop-outs among those who arrived in the earliest years; then, a distinct change appears in the slope, whereby the proportion of individuals dropping out of high school increases practically linearly with each additional year beyond age 7 or 8. On average, 14.7% of men who arrived at age 8 or younger did not obtain a high school diploma; for those who arrived after that, the figure was 19.7%. For women, these averages were 11.3% and 18.2%, respectively. A linear least-squares regression model fit to these data in a way that permits a break in the constant and slope of the relationship at the turning points of the local polynomial smooth in Figure 1 suggests that the chances of being a high school drop-out rise by 1.2 percentage points for every year that a boy arrives in the country after age 8 and by 1.5 percentage points for every year a girl arrives after age 7.[10]

The results in Figure 1 also support the possibility of other breaks, particularly after age 14 for men. This is likely associated with the institutional structure of the Canadian education system, which at the time appropriate for the sample of individuals under study had a minimum school leaving age of 16. If a boy arrived in the country at the age of 15 or higher he was much more likely not to graduate from high school than if he had arrived at age 13 or 14. A similar jump in the chances of being a high school drop-out also occurs for girls of the same age; in addition, there is a distinct increase after the age of 12.

There are at least three cautionary issues that need to be addressed before these findings can be causally related to sensitive periods in language acquisition. The first is the issue of self-selection, which has already been noted. If, in some sense, unobserved family characteristics vary across the age-at-arrival distribution in a way that implies that children who arrive earlier are raised in a family environment more favourable to their long-run success, then the results in Figure 1 overstate the relative success rates during the early years, compared to a randomly selected group of individuals. The sharp distinction at the age of 7 or 8 may not be as clear, and the overall level of dropping out may not be as low, depending upon how these unobserved influences vary over the age distribution during these earlier years. A similar reasoning, but opposite in direction, applies to the findings at older ages.

Second, there could very well be heterogeneity along other dimensions such as country of origin. Immigrants to Canada come from a wide range of countries, and therefore previous exposure to English and French varies significantly. It could be that the similarity of the language in the country of origin to English or French—and hence the difficulties that must be overcome in learning the new home-country language—also varies across the distribution of age at arrival. A similar bias could result if those arriving at younger ages are disproportionately from English-speaking or French-speaking countries, or from countries with a language close to English or French. If this were the case, the ease of learning one of the official languages would systematically vary across the age distribution as a result of country-of-origin effects.

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9. The smooth is meant only as a descriptive device to aid visualization of the patterns in the data. It is not the correct tool for identifying a discrete change in these patterns, and is used only to highlight a possible turning point worthy of more detailed analysis.

10. These weighted regressions explain 97% of the total variation in the data for men and 95.1% of the total variation in the data for women. Using a turning point of age 8 for men also leads to the highest R-squared among all possible thresholds, between age 5 and age 12. For women, this happens at age 10.

Figure 1
Proportion of individuals arriving in Canada before the age of 18
without a high school diploma in adulthood, by age at arrival and gender
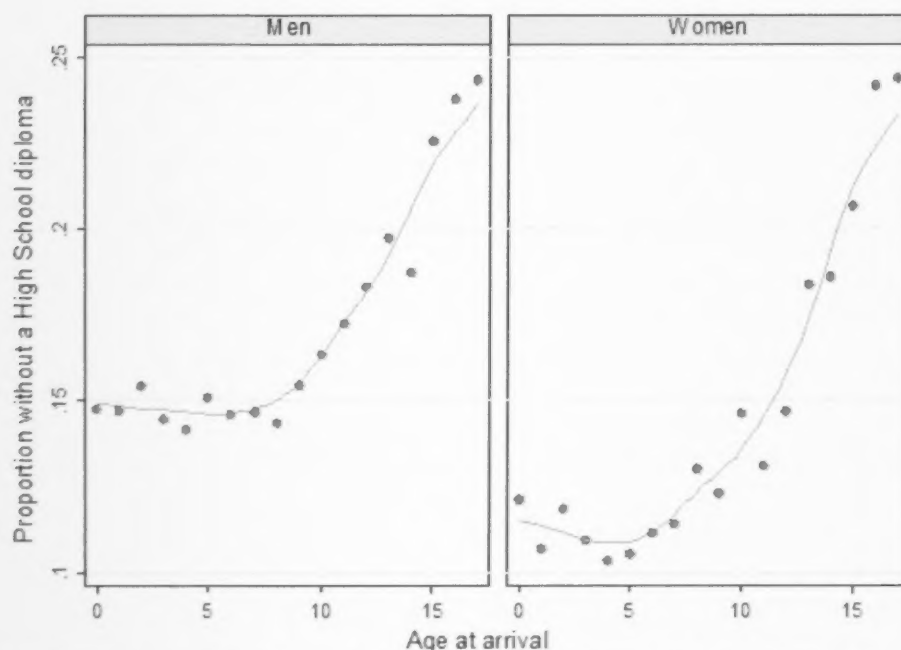
Note: Derivation by author from Statistics Canada, 2006 Census using analytical files described in the text. Each data point represents the proportion of individuals by age at arrival without a high school diploma who are 35 to 55 years of age in 2006. The continuous line is an estimated local polynomial smooth based upon weighted data, and calculated using a linear smooth and an Epanechnikov kernel.

Finally, and related to both of these factors, prior exposure to one of the official languages, even when the source country is not an English-speaking or French-speaking country, could vary. As mentioned, age at arrival should not necessarily be equated with age of acquisition or with age of first exposure; which could depend on the country of origin, formal schooling in the source-country context, parental investments, or exposure to relatives in or visits to English-speaking or French-speaking countries. When those who arrive at a young age are more likely to have been exposed to one of the official languages before arriving to Canada, their outcomes may tend to be more favourable than otherwise and bias the findings toward the type of non-linear pattern displayed in Figure 1. This could very well be the case for parents who are preparing their children for migration to the country or who chose the country of destination according to where they expect their children will be more likely to succeed.

5   Results by country and language of origin

These cautions are addressed by examining the patterns in high school graduation by language of origin and mother tongue. The sample frequencies by age at arrival for the 11 groups of countries of origin according to their linguistic distance from English were calculated for men and women, respectively.[11] These raw sample sizes make clear, for example, that the patterns in the overall data—namely a greater tendency for children to arrive between the ages of 1 and 5—are due in large measure to immigrants from just two regions: the United Kingdom and those countries linguistically close to English (particularly those countries other than Portugal and Italy). The suggestion is that the overall group of individuals who arrived in the country at a particularly young age are disproportionately from English-speaking countries and countries where the linguistic challenge in learning English is lowest. As such, if they are less likely to drop out of high school as a result of having lower linguistic challenges in learning the dominant language, they will contribute to an overstatement of the educational attainment—relative to a randomly chosen child of the same age—for the group of children actually observed in the sample. This selection effect combined with an opposite tendency at the other end of the age-at-arrival distribution, namely an over-representation of children from countries with languages that are not similar to English, could produce the pattern depicted in Figure 1. Children arriving in the country at the oldest ages, however, were somewhat more representative of the entire population of children. It is the case that those from countries with languages least like English have an overall tendency to arrive at a later age, but this was also the case for children arriving from countries other than the United Kingdom or the United States in which the language spoken is English.

There are perhaps three messages from this information. First, all other things equal, it should be expected that any patterns in the likelihood of being a high-school drop-out across age at arrival should be muted for those from English-speaking countries of origin, and, if they are present, such patterns should be due to factors other than language or to more subtle language effects, for example those associated with accent.

Second, the causal role of language should be clearest for those countries with the greatest distance from English, subject to some control being made for non-language effects. It should also be clearest for those individuals who came from Portugal (and possibly those who came from Italy), since the frequency distribution does not appear to vary by age at arrival, and, hence, the selection problem is likely to be less. The best comparison group by which to judge the causal impact of age at arrival and to net out these other effects is most likely to be those immigrants from English-speaking countries other than the United Kingdom or the United States. The reason for this is that the pattern in the frequency distribution by age at arrival is roughly similar for these countries as it is for countries that are least like English, that is, those with a low linguistic distance score.

Third, the possible selection bias needs to be addressed by controlling for variations in the degree of parental investments in children across the age-at-arrival distribution. One way to do this with the available data is to attempt to measure age of first exposure. The Canadian census contains a number of indicators of language ability. The closest measure that can possibly speak to the age of first exposure is the so-called "mother tongue." Question 16 of the census asks: "What is the language this person first learned at home in childhood and still understands?" The possible responses are: "English"; "French"; and "Other." The fraction of individuals whose first language was not one of the two official languages is, as might be expected, low among those from English-speaking regions of origin and relatively high among non-English-speaking regions. However, in some of these latter cases, the fraction also varies systematically by age at arrival, somewhat more so for men. In particular, 74.7% of men and

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11. As discussed in Section 3, there is no equivalent measure of linguistic difference from French.

80.2% of women from countries (other than Italy and Portugal) with a high similarity to English have a language other than English or French as their mother tongue, but only 67.4% of men who arrived at the age of 8 or younger do so, compared to 87.8% of those who arrived after 8 years of age. For women, these proportions are 74.9% and 89.4%.

Just as importantly the results also show a systematic rise in the proportion of immigrant children with a non-official language as a mother tongue from countries that have the lowest similarity to English. This is particularly so for men. The proportion of those with a mother tongue that is not an official language of Canada increases on average by more than 1 percentage point for each additional year for those from French-speaking countries, those with a high linguistic score (other than Italy and Portugal), those from Hong Kong and India, and in the case of men from countries with a low or medium linguistic score. There is only a very shallow positive gradient for both men and women from Italy and Portugal (see Table A.3 in the Appendix).

These patterns suggest that the linguistic challenges that a cohort of young immigrants faces vary not just according to their region of origin, but also within the region of origin. More importantly, it does so in a way that suggests that those arriving at younger ages will likely find it easier to learn English because it was more likely to be the language they first learned.

At the same time it should be noted that, to some degree, these patterns may overstate the potential for this selection problem. The question on mother tongue refers to the language first learned and still understood, not simply to the language first learned. So some fraction of individuals may have had a first exposure to a non-official language, subsequently lost the ability to understand this language, and answered the census question by responding accordingly. The outcomes for those from Italy and Portugal are in this sense likely to be among the outcomes of the groups least affected by a selection problem, as the gradient between age at arrival and mother tongue being a non-official language is the flattest and will therefore likely be even flatter if the question truly captured first exposure. In other cases, it will be important to control for mother tongue in the hope of capturing a more accurate estimate of the impact of age at arrival on schooling success.

Table 2 offers estimates from a series of least-squares models that attempt to address these issues by controlling for mother tongue and region of origin. The results presented are for the choice of threshold maximizing the adjusted R-squared among all possible thresholds for the age at arrival between 5 and 12. The preferred model is the last one presented for each gender, indicating that the best fitting model uses a threshold of age 8. For men, this is not a significant change from what visual inspection of Figure 1 would suggest. For women, a threshold at age 10 maximizes the adjusted R-squared when mother tongue is controlled for as well as when it is not. But the suggestion in the last column of the table, which also controls for region of origin, suggests that this is due to compositional changes in the underlying sample.

These results continue to hold when a more detailed analysis is undertaken by region of origin. A summary of the regression results is offered in Table 3 for men and Table 4 for women. These tables report the coefficients of the threshold maximizing the R-squared after searching over all possible thresholds from 5 to 12 years of age. The regressions also control for mother tongue.

Table 2
Least squares regression results for most likely thresholds (T) of age-at-arrival impacts on not having graduated from high school, men and women

	Men			Women		
	T = 7	T = 7	T = 8	T = 10	T = 10	T = 8
			coefficient			
Variables						
Age at arrival	0.0001 [3]	-0.0018 [3]	-0.0008 [3]	0.0022 [3]	0.0012 [3]	-0.0005 [3]
Threshold (T)	-0.0138 [3]	-0.0081 [3]	0.0025 [3]	-0.0123 [3]	-0.0100 [3]	-0.0107 [3]
T × age at arrival	0.0112 [1]	0.0106 [1]	0.0127 [1]	0.0168 [1]	0.0152 [1]	0.0163 [1]
Mother tongue	...	0.1120 [1]	0.1430 [1]	...	0.1120 [1]	0.2200 [1]
Constant	0.1500 [1]	0.0930 [1]	0.0592 [1]	0.1310 [1]	0.0725 [1]	0.0218 [1]

	Men			Women		
	T = 7	T = 7	T = 8	T = 10	T = 10	T = 8
Indicators for region of origin	none	none	eleven	none	none	eleven
Diagnostic statistics						
Adjusted R-squared	0.0980 [2]	0.2840 [2]	0.7900 [2]	0.1680 [2]	0.3580 [2]	0.7330 [2]
F test - p value	0.0010 [2]	0.0000 [2]	0.0000 [2]	0.0000 [2]	0.0000 [2]	0.0000 [2]

1. Marginal significance is less than or equal to 0.05.
2. Marginal significance is greater than 0.05 and less than or equal to 0.10.
3. Marginal significance is greater than 0.10.
Notes: Derivation by author from Statistics Canada, 2006 Census, using analytical files described in the text. T refers to the threshold used in the estimation of a piece-wise linear least squares model. Results presented are those for models with highest adjusted R-squared among all possible thresholds from 5 to 12 years. Sample size is 198 observations on weighted averages by age at arrival from 0 to 17 for each gender, representing 50,253 men and 51,631 women. All regressions use analytical weights. Standard errors are robust to heteroscedasticity. Region of origin controls refer to indicator variables for the eleven regions categorized by linguistic distance from English and French as described in the text, with the omitted category for the sake of the regression analysis being the group of English-speaking countries other than the United Kingdom or the United States. P value for the F test refers to the null hypothesis that all regressors except the constant equal 0.

For men born in the United Kingdom, the United States, and other countries in which English is the language spoken, there is at best a weak relationship between age at arrival and educational attainment. For those from countries other than the United Kingdom or the United States, the break point occurs at age 11, with the chances of not obtaining a high school diploma increasing discretely by about 4 percentage points, but not changing any further, with each subsequent year. The model has relatively low explanatory power. The preferred results for the United Kingdom have higher explanatory power, but suggest that not having high school credentials is actually higher for those arriving at younger ages. For men from the United States, the preferred model does not involve a threshold, but rather a linear increase in the chances of dropping out. For women from the United States, there is a break, but it occurs very early, at age 5. All this said, the overall chances of not having a high school diploma are relatively low, never over 15% (with the major exception being men who came to Canada from the United States after the age of 10).

This contrasts sharply with the results for those from non-English-speaking countries highlighted in the next panels of the tables. Considering regions whose languages have a high similarity to English suggests a break point at age 5 or 6, the exception being Italy, where it is 9 for men and 11 for women. The least-squares models fit the data very tightly, explaining up to 97% of the variation in the Italian and Portuguese data and more than 70% of the data for the remaining countries. In large measure, it is the data from this group of countries that drive the overall results depicted in Figure 1.

The high school drop-out rates are particularly high for those from Portugal, reaching over 60% for those who arrived after the age of 15. This high overall level is well known, as described by Nunes (2008) and studied in more detail in Ornstein (2007, 2006a,b). This is a community that began its migration to Canada in the 1950s and continued to immigrate into the 1990s. Nunes notes that these migrants were predominantly from poor, rural regions of Portugal and had relatively low levels of education. In this sense, Portuguese immigrants are a self-selected group, and their very low overall high school completion rate relative to other immigrant groups is not a new finding. What is new and particularly relevant in the current context is that this pattern varies markedly according to age at arrival, being two to three times lower for those who arrived as pre-schoolers compared to those who arrived as adolescents. A roughly similar story can be told for those from Italy.

Even when the levels of high school graduation are lower, the pattern across age at arrival is similar for countries whose languages have the least resemblance to English. With the single exception of women from countries other than Hong Kong or India, the threshold that maximizes the R-squared occurs at age 9 or younger, with values always higher than 0.75 and as high as 0.98.

Table 3
Least squares regression results for most likely thresholds (T) of age-at-arrival effects on not obtaining a high school diploma, by origin region according to linguistic distance from English, men

	Turning point with maximum R-squared (T)	Age at arrival	Threshold (T)	T × age at arrival	R-squared	P value for F-test of all regressors equal to zero
	years	coefficient			R-squared	P value
English						
Rest of world	11	-0.00215 [3]	0.04270 [1]	-0.00546 [3]	0.2790 [2]	0.07050 [2]
United Kingdom	5	0.00417 [3]	-0.02090 [1]	-0.00539 [1]	0.4980 [2]	0.03890 [2]
United States	none	0.00353 [1]	...	...	0.4010 [2]	0.01930 [2]
High similarity to English						
Italy	9	-0.0111 [1]	0.0799 [1]	0.0302 [1]	0.9510 [2]	0.0 [2]
Portugal	6	0.0028 [3]	0.0644 [1]	0.0256 [1]	0.9690 [2]	0.0 [2]
Rest of world	6	0.0140 [3]	-0.05220 [1]	0.000116 [3]	0.7430 [2]	0.00010 [2]
Low similarity to English						
Hong Kong	5	-0.00766 [1]	0.01930 [3]	0.01360 [1]	0.8680 [2]	0.0 [2]
India	7	-0.0160 [3]	-0.0121 [3]	0.0377 [1]	0.8920 [2]	0.0 [2]
Rest of world	7	0.00826 [3]	-0.0490 [1]	0.02250 [1]	0.9620 [2]	0.0 [2]
Medium similarity to English	none	0.00466 [2]	...	...	0.5320 [2]	0.00050 [2]
French	6	-0.00387 [2]	0.120 [1]	-0.00782 [2]	0.7450 [2]	0.00030 [2]

1. Marginal significance is less than or equal to 0.05.
2. Marginal significance is greater than 0.05 and less than or equal to 0.10.
3. Marginal significance is greater than 0.10.
Notes: Derivation by author from Statistics Canada, 2006 Census using analytical files described in the text. T refers to the threshold used in the estimation of a piece-wise linear least squares model. Results presented are those for models with highest R-squared among all possible thresholds from 5 to 12 years. Sample size for each line is 18 observations on weighted average attainment by age at arrival from 0 to 17. All models include a constant term and a control for the proportion of each age group not having English or French as a mother tongue. All regressions use analytical weights. Standard errors are robust to heteroscedasticity. P value for the F test refers to the null hypothesis that all regressors except the constant equal 0.

Table 4
Least squares regression results for most likely thresholds (T) of age-at-arrival effects on not obtaining a high school diploma, by origin region according to linguistic distance from English, women

	Turning point with maximum R-squared (T)	Age at arrival	Threshold (T)	T × age at arrival	R-squared	P value for F-test of all regressors equal to zero
	years	coefficient			R-squared	P value
English						
Rest of world	11	0.000573 [3]	-0.02590 [3]	0.01070 [2]	0.3960 [2]	0.00510 [2]
United Kingdom	8	-0.002960 [1]	0.01580 [2]	0.000655 [3]	0.760 [2]	0.0 [2]
United States	5	-0.00573 [3]	0.0120 [3]	0.01350 [1]	0.6620 [2]	0.00010 [2]
High similarity to English						
Italy	11	0.00672 [3]	0.03690 [3]	0.03990 [1]	0.9760 [2]	0.0 [2]
Portugal	5	0.00317 [3]	-0.00469 [3]	0.03090 [1]	0.9660 [2]	0.0 [2]
Rest of world	6	-0.00191 [3]	0.04820 [2]	0.00577 [3]	0.7170 [2]	0.00010 [2]
Low similarity to English						
Hong Kong	9	-0.00744 [1]	-0.05020 [1]	0.01880 [1]	0.7520 [2]	0.0 [2]
India	8	-0.00292 [3]	-0.02240 [3]	0.03710 [1]	0.9520 [2]	0.0 [2]
Rest of world	11	0.00146 [3]	0.03490 [1]	0.03560 [1]	0.9870 [2]	0.0 [2]
Medium similarity to English	5	0.00401 [1]	-0.04480 [1]	0.00428 [1]	0.8780 [2]	0.0 [2]
French	12	-0.00150 [3]	0.06940 [2]	-0.01430 [2]	0.4950 [2]	0.01470 [2]

1. Marginal significance is less than or equal to 0.05.
2. Marginal significance is greater than 0.05 and less than or equal to 0.10.
3. Marginal significance is greater than 0.10.
Notes: Derivation by author from Statistics Canada, 2006 Census using analytical files described in the text. T refers to the threshold used in the estimation of a piece-wise linear least squares model. Results presented are those for models with highest R-squared among all possible thresholds from 5 to 12 years. Sample size for each line is 18 observations on weighted average attainment by age at arrival from 0 to 17. All models include a constant term and a control for the proportion of each age group not having English or French as a mother tongue. All regressions use analytical weights. Standard errors are robust to heteroscedasticity. P value for the F test refers to the null hypothesis that all regressors except the constant equal 0.

6 Conclusion

This analysis of the education outcomes of a large sample of adults who came to Canada as children suggests the following three conclusions. First, there appears to be a pattern which indicates that the risk of not obtaining a high school diploma varies with age at arrival in a way that is consistent with a sensitive period in learning a second language. The risk of not being a high school graduate may not vary with age at arrival for those who came to Canada before 9 years of age, but it does increase by over 1 percentage point for every year past this age. There also appears to be discrete increases in this risk at around the age of 14 or 15, which may reflect the fact that, during the relevant period, the legal school-leaving age was 16 years, as well as a discrete increase for women at after 12 years of age. These results are robust to controls for the possibility that first exposure to English or French occurred before migration.

Second, these patterns may have something to do with the challenges that children face in learning a second language since they vary in a predictable way according to the linguistic distance of the language in the country of origin from English. There is no discernable pattern between high school graduation and age at arrival for those who came to Canada from English-speaking or French-speaking countries. Though the overall levels in high school graduation vary significantly across other countries of origin, the nature of the pattern is the same: no change in the early years, followed by a distinct change in slope. The threshold for this change corresponds to the first years of primary school, being reasonably estimated to be as young as age 5 for some regions and likely no older than age 9 for all the others.

Third, the underlying reasons for these findings require further study. The research had the benefit of using a large and diverse sample of immigrants, and controlled for some of the more important aspects of the underlying heterogeneity. The focus was on education outcomes because the issue has policy relevance, but the patterns uncovered are distinct and robust in a way that has not been addressed in previous research focusing on language proficiency. More detailed analysis is necessary to discern the degree to which the findings are due to maturational changes in the cognitive capacities of children to learn a second language, sensitive periods in their social development, or institutional features of the education system whereby the latter is not sufficiently attune to the needs of, and challenges facing, children in senior primary or young adolescents.

Future research, particularly in a comparative context, would be helpful in order to discern the relative roles of these factors, particularly that of institutional design. It may well be that education systems that track students into different streams at a very early age reinforce or aggravate pre-existing risks associated with cognitive and social integration. This would be a particularly policy-relevant issue upon which to focus, one that underscores the need to appreciate the distinct challenges confronting immigrant children.

Appendix

Table A.1
Sample selection rules used in the creation of the analytical file from the 20% file of the 2006 Census

Sample selection rules	Sample count	Population total
	number	
Total adult population 35 to 55 years of age (inclusive)	2,137,809	10,225,084
Exclusions for out-of-scope cases or anomalies		
Institutional residents	53,111	53,111
Refugees	15,610	69,766
Cases with rare characteristics[1]	5,908	28,534
Residing in one of the three territories	20,333	31,408
Total population after exclusions	2,042,847	10,042,265
Exclusions for immigrant status		
Canadian born with Canadian born parents	1,315,123	6,321,972
Canadian born with Foreign born parents	258,099	1,302,630
Foreign born, age at arrival older than 20 years	332,559	1,717,506
Total population after exclusions	137,066	700,157
Exclusions for outlying values[2]		
Foreign born, age at arrival 20 years or younger with employment income of outlying or of negative value	1,053	5,347
Analytical sample with age at arrival of 20 years or younger	136,013	694,810

1. Some individuals are coded as Canadian-born with respect to the age at immigration variable but at the same time coded as being born in Canada. Similarly, some others are coded in the census as both Canadian-born and as having an age at immigration. This can occur in some rare situations. For example, a mother giving birth to her baby in Canada can move back to her country of origin shortly after. Then, if the child immigrates at a later date, he or she would legitimately have an age at immigration despite having been born in Canada.
2. Employment income is considered as outlying when greater than three standard deviations from the mean employment income for the overall population of immigrants. Individuals whose employment income was negative are also removed from the sample since this is probably a reflection of temporary losses for self-employed individuals.

Note: The analysis in the text is based upon a sample of 111,302 individuals less than 18 years of age at arrival. Further, the analysis using region of origin classified according to linguistic distance from English and French is based upon a sample of 101,884. This latter sample restriction reflects the fact that more than one language is spoken in some countries. When the proportion of all immigrants in 2006 from a particular country reporting more than one language exceeds 25%, the country is not assigned a language and individuals from that country are excluded from the analysis.

Table A.2
Categorization of countries of origin according to language spoken

English

Anguilla	Ireland		
Antigua and Barbuda	Republic of South Africa		
Bahamas	Australia		
Barbados	New Zealand		
Bermuda			
Cayman Islands	United States and		
Dominica	United Kingdom are		
Grenada	categorized separately		
Jamaica			
Montserrat			
Saint Kitts and Nevis			
Saint Lucia			
Saint Vincent and Grenadines			
Trinidad and Tobago			
British Virgin Islands			
Guyana			

French

Saint Pierre and Miquelon	Martinique
Guadeloupe	France
Haiti	Réunion
	Gabon

Medium Score

Bulgaria	Macedonia
Czech Republic	Serbia and Montenegro
Slovakia	Slovenia
Hungary	Yugoslavia n.o.s.
Poland	Eretria
Estonia	Afghanistan
Finland	Iran
Bosnia and Herzegovina	Turkey
Croatia	Philippines

High Score:
Lowest linguistic distance from English

Costa Rica	Austria
El Salvador	Germany
Guatemala	Liechtenstein
Honduras	Netherlands
Mexico	Romania
Nicaragua	Belarus
Panama	Republic of Moldova
Cuba	Russian Federation
Dominican Republic	Ukraine
Puerto Rico	USSR n.o.s.
Argentina	Denmark
Bolivia	Iceland
Brazil	Norway
Chile	Spain
Colombia	Angola
Ecuador	Kazakhstan
Paraguay	Kyrgyzstan
Peru	Tajikistan
Uruguay	Uzbekistan
Venezuela	
	Italy and Portugal are
	categorized separately

Low Score:
Highest linguistic distance from English

Greece
Palestine / West Bank / Gaza
Peoples' Republic of China
Macau
Japan
North Korea
South Korea
Taiwan
Brunei Darussalam
Laos
Vietnam
Fiji

Hong Kong and India are
categorized separately

Note: "n.o.s." stands for "not otherwise specified."

Table A.3
Weighted least squares estimates of the gradient in the proportion of immigrant children with a non-official language as mother tongue, by age at arrival and region of origin, men and women

	English, rest of world	United Kingdom	United States	French	Italy	Portugal	High, rest of world	Hong Kong	India	Low, rest of world	Medium
	weighted least squares coefficient										
Men	-0.003	-0.000	-0.001	0.011	0.008	0.006	0.022	0.014	0.023	0.010	0.011
Women	-0.003	-0.000	-0.002	0.015	0.006	0.005	0.016	0.010	0.018	0.006	0.008

Notes: The regions of origin have been grouped into 11 categories, based on linguistic characteristics and sample size of country of origin as described in the text. The results, except those for the United Kingdom, are statistically significant at the 0.05 level at least, using robust estimates of the standard errors. The relatively sharp gradients for those from Hong Kong and India may reflect not only the English-related history of these regions, but also the emigration of ex-patriots, ethnicity not being controlled for in these regressions.
Source: Author's calculations using 2006 Census data from Statistics Canada.

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